## Fittings

When selecting a fitting, consider the

- rated working pressure of the fitting and system.
- compatibility and operating temperature of the fitting material with the system fluid.
- availability of replacement units or component parts.
- proven quality, dependability, and cost of the fitting in relation to its required performance.

Assume all steel pipe fittings (unless otherwise marked or identified) are rated at 150 psig and all brass pipe fittings are rated at 125 psig. A fitting or valve marked "125 WOG" is good for up to 125 psig of water, oil, or gas at room temperature. A fitting marked "150" may be good for up to 275 psig of gas pressure, but it is not to be used at pressures over 150 psig unless the higher pressure rating can be proved. Refer to the manufacturer's catalog or in-house reference.

In the following text regarding fittings, MAWP will usually be determined by tube size (i.e., OD/ID). However, if the fitting incorporates a "weaker element," such as in a tube-to-pipe adapter, the pipe thread will usually have a lower MAWP than the tubing used. Therefore, the lower MAWP must be used.

### National Pipe Taper Thread (NPT) Fittings

- Seals by interference fit. Must use sealant/lubricant.
- Do NOT interchange with National Pipe Straight thread (NPS).
- Forged fittings are available for MAWP's of 1,000; 2,000; 3,000; 4,000; and 6,000 psig. NEVER use at pressures over 10,000 psig.

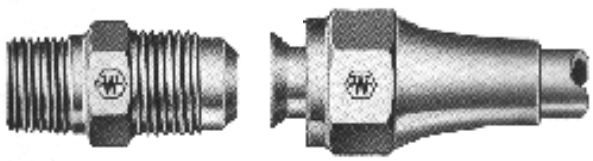
### Straight Thread (Face Seal) Fittings

- Usually stainless steel.
- Use a gasket or elastomer sealing device.
- Used for ultra clean vacuum and pressure systems. Refer to the manufacturer's catalog for working pressures.

### Flare Fittings

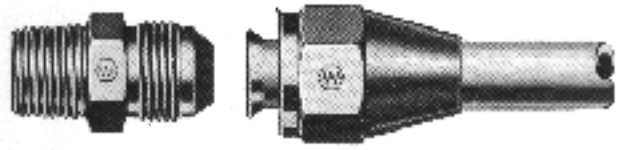
Two common types are:

- 45° flare



-two-piece. Used with copper, brass, aluminum and welded steel hydraulic tubing.
-Tube end flared to seal on mating part.
-Pressure rating determined by tube dimensions.

- 37° flare



-Three-piece. Used with brass, aluminum, steel and stainless steel.
-Pressure rating determined by tube dimensions.
-The minimum and maximum wall thickness for an efficient 37° flare joint are:

**Material: Steel, Stainless Steel, Brass, Aluminum**

| Tubing o.d. (Inches) | Wall thickness (inches) (Min. / Max.) |
|---|---|
| 1/8, 3/16 | .010 / .035 |
| 1/4, 5/16, 3/8 | .020 / .065 |
| 1/2 | .028 / .083 |
| 5/8 | .035 / .095 |
| 3/4, 7/8 | .035 / .109 |
| 1 | .035 / .120 |

To assemble flare fittings:

- Cut tubing off squarely.
- Remove burrs and clean tubing.
- Install collar (if any).
- Flare to correct angle with proper tools.
- Assemble completely and tighten fittings.
- Disassemble and check.
- Reassemble and retighten about 1/8 turn past finger tight. If required, refer to manufacturer assembly-torque specifications.

**Flareless or Bite-Type Fittings**

- Pressure seal achieved by a simple or two-piece ferrule system that either bites or deforms tube O.D. when fitting is tightened.
- Consider proper hardness when sketching tubing.
- DO NOT interchange different manufacturer's components.
- Pressure rating determined by tube dimensions.
- The minimum and maximum wall thickness for an efficient bite-type joint is:

**Material: Steel, Stainless Steel, Copper**

| Tubing o.d. (inches) | Wall thickness (inches) (Min. / Max.) |
|---|---|
| 1/8 | .028/.035 |
| 3/16 | .028 / .049 |
| 1/4 | .028 / .065 |
| 3/8 | .035 / .065 |
| 1/2 | .049 / .083 |
| 3/4 | .065 / .109 |
| 1 | .083 / .120 |

In general, to assemble bite-type flareless fittings:

- Cut tubing off squarely.
- Remove burrs and clean tubing.
- Install gland nut and sleeve (or ferrules).
- Place tubing end into fitting body and tighten gland nut until tubing will not rotate by hand. A drop of oil on the male threads will help.
- Tighten 1-1/4 turns.
- Disassemble and check.
- Reassemble and retighten about 1/8 turn past finger tight.
- NOTE: Assembly and reassembly procedures may vary between manufacturers with regard to fitting design, tube diameter, tube wall thickness, etc.

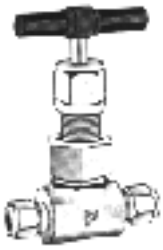
Flareless fittings for higher pressures up to 15,000 psig MAWP may be used.

- Fittings for 1/16 in. and 1/8 in. o.d. tubing are standard.
- Employs a single sleeve that "clamps" onto tubing.
- Gland nut will "bottom out" when assembly is properly made.
- The minimum and maximum wall thickness for an efficient bite-type joint on higher pressure fittings are:

**Material: Stainless Steel**

| Tubing o.d. (inches) | Wall thickness (inches) Min. / Max. |
|---|---|
| 1/16 | .017"/.028" |
| 1/8 | .032"/ .053" |

## Valves



Valves are used to control the flow of fluids. There are many types and manufacturers available and their applications frequently overlap.

When selecting a valve consider:

- operating pressure/temperature,
- flow requirements,
- fluid compatibility,
- connection type and size,
- flow pattern,
- flow control (i.e., shut off, regulating, metering).

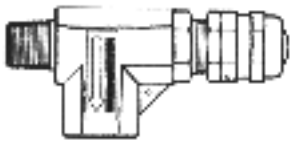
Common valve types in the low to intermediate pressure range include ball, plug, metering, and diaphragm valves. These are available for a wide variety of applications and have various end connections available. Always refer to manufacturers for specific use.

Valves in the higher pressure range (up to 150 ksi) typically employ coned and threaded connections. Also, non-rotating stems are commonly used which minimize leaks and result in longer service life. A variety of stem tips are available depending on flow requirements.

### Coned and Threaded Connections

Coned and threaded fittings may be used to 150,000 psig, MAWP depending on manufacturer's design. Coning provides line contact sealing resulting in a minimal seal area. Threading positively locks tube to fitting using a collar. Fittings for 1/4-, 3/8-, and 9/16-in.-o.d. tubing are standard. The tubing and collar are left-hand threaded, and two to three threads are exposed at the tube end when the collar is screwed tightly onto a properly threaded tube. Since there are several types of coned and threaded connections, it is important that the correct tubing, collars and gland nuts are used and not interchanged. Special hand tools are available for coning and threading high-pressure tubing.

## Relief Devices



Pressure sources are to be limited to the MAWP of the lowest rated system component. When sources cannot be limited, the use of a pressure relief device is required. Common relief devices are spring loaded relief valve, and a rupture disc assembly.

All manned area pressure vessels must be protected by a relief device that is set at a pressure not exceeding the MAWP of the vessel.

Only authorized personnel are permitted to set and seal relief devices on noncoded pressure vessels and systems. For utility water boilers, steam boilers and compressed air receivers that are under the jurisdiction of the state, only those so authorized may set and seal those relief devices.

[Whenever possible, use ASME code-approved (ASME UG-125-136) or specially stocked relief devices.]

Inspect, reset or replace all relief devices on a periodic basis. A minimum of a 3 year interval is recommended. If the relief devices were installed by an outside contractor, have components rechecked at the end of the contract period.

***Cautions:***

- Never place a valve between a relief device and the component it is installed to protect.
- Never set a relief device above the MAWP of the lowest rated system component(s) it is installed to protect.

• Locate and orient relief devices so that their discharge is not hazardous to personnel.

• Install relief devices of adequate total flow capacity. When all supply ports are open, the pressure must never exceed 110% of the MAWP.

• Do not reset relief devices unless you are specifically authorized to do so.

## Pressure Gauges

Pressure gauges indicate system pressure and are precision instruments. They are available with a variety of end connections, levels of accuracy, materials of construction and pressure ranges.

When selecting and installing a pressure gauge, consider the following:

• Use gauges graduated to about twice the MAWP of the system - never graduated to less than 1.2 times the MAWP. Be sure that gauge materials are compatible with the system fluid. (These rules apply to liquid-pressure gauges.)

• Use safety-type gauges (with shatter-proof faces, solid fronts, and blowout backs) or protect operators with a tested, approved gauge safety shield. This applies to all gas pressure gauges more than 4 inches (100 mm) in diameter graduated to over 200 psi (1.4 MPa), gas pressure gauges less than 4 inches in diameter graduated to over 5000 psi (34.5 MPa), and to all liquid pressure gauges more than 4 inches in diameter that are graduated to over 20,000 psi (138 MPa).

• Protect a gauge that is subject to excessive pressure surges or cyclic pulses by installing a throttling device, such as a pulsation dampener (preferred), a pressure snubber, a gauge saver, or a restricting orifice. Some gauges use a throttle screw in the tube socket to dampen surges.

• Make sure there is no oil or organic materials in gauges used on oxygen systems - hydrocarbons and oxygen can combine explosively. Never use a gauge for oxygen that has been previously used on any other service. Clean all gauges used on high-purity gas systems.

• Protect with a relief device as required to prevent the pressure from exceeding the full-scale reading of the gauge.

• Never use liquid filled gauges with strong oxidizing agents such as oxygen, chlorine, or nitric acid.

## Flexible Hose

Use flexible hose only where it is impractical to use metal tubing or pipe. Flexible hose has a limited life dependent on a given service and failure to follow manufacturer's recommended actions can result in shortened service life or failure. Maximum recommended shelf life for rubber hose is approximately 8 years. When specifying and installing a flexible hose, consider the following:

• Rated Working Pressure - do not use at pressures over 1/4 of the minimum rated burst pressure stated by the manufacturer.

• Fluid compatibility - do not use on toxic or radioactive fluids since gases tend to permeate through hoses. Specially approved hoses may be used in certain flammable gas applications.

• Avoid sharp bends - do not bend or flex hose to a radius smaller than recommended and do not subject hose to torque or tension.

• Secure ends - all hose ends should be secured with a hose restraint to prevent "whipping" if hose or fitting fails. This includes where two hoses are coupled together.

• Hose length and routing - keep hose length as short as possible. Consider length changes under pressure, motion and vibration. Protect or guide hose to minimize abrasion kinking or excessive flexing.

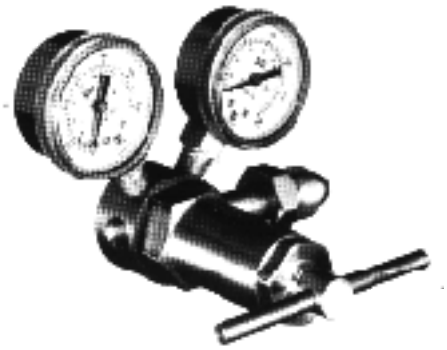
• Periodic inspection - have maintenance personnel perforate inert gas hose to prevent blistering. repair or replace any hoses showing leaks (pinholes), burns, wear blistering, or other defects.

## Flash Arresters and Check Valves

• Equip every flammable gas drop regulator hose connection with a flash arrester or a check valve. If the flammable gas is to be (or could be) cross-connected with oxygen or compressed air, a flash arrester must be installed in the flammable gas line and a check valve placed in the oxygen or compressed air line. This applies to all single-and-multiple-station installations and to all portable equipment.

• Equip all oxygen drops with a check valve. This applies to single-and-multiple-station installations and portable equipment.

## Regulators



The distribution systems of gas cylinders consist of regulators and manifolds. For a cylinder to be effective and safe, the regulator must take in gas from the cylinder and reduce the pressure to a lower working pressure while simultaneously controlling the flow rate. It is important that the correct regulator be obtained, consistent with the gas involved and the operation intended. Manifolds distribute and control gas flow from regulators.

NEVER attempt to perform any type of repair to regulators.

•Before installation, all regulators should be taken to the authorized personnel for inspection, adjustment and tagging.

•For temporary storage, place used regulators in plastic bags to keep them clean.

•Supervisors should make periodic surveys of their areas for surplus regulators. These should be sent to authorized maintenance personnel for examination, cleaning, adjustment, repair and tagging for future use.

•Only authorized maintenance personnel can alter or repair regulators.

•When removing regulators from flammable, toxic, or radioactive systems, make sure that all hazardous gas has been safely vented (and purged if required) from the entire regulator.

•Use only regulators that are designed and approved for the gas and cylinder with which they are used. Make sure that the CGA connection on the regulators corresponds with those on the cylinder-valve outlet. Never force connections that do not fit perfectly. Make sure the cylinder valve and regulator connections are free of dirt, oil, grease, and any other foreign material. Use only oxygen regulators for oxygen service.

•Do not lubricate any part of the regulator or cylinder valve.

•Properly label regulator with fluid being used.

•Line regulators are only permitted for inline installations up to a maximum pressure of 150 psig (1 MPa).

•Two-stage regulators for inert gas are equipped with two relief valves that protect the regulator diaphragms and gauges from excessive overpressure. Relief valves on regulators for use with flammable, toxic, or radioactive gases must be safely vented.

•In several facilities authorized maintenance personnel will adjust two-stage regulators so that the output pressure does not exceed 75% of the highest output-gauge reading. They will also set the low-side relief valve to open at a value below the highest graduation on the low-side gauge.

•Single-stage cylinder regulators (except acetylene regulators) are equipped with a single-relief device that is set to open at a value below the highest graduation on the low-side gauge. The authorized maintenance personnel may also adjust these regulators to limit the output pressure to 75% of the highest output-gauge reading.

## Manifolds

•Order manifolds from the appropriate personnel. Only authorized maintenance personnel can assemble manifolds for compressed-gas cylinders (refer to in-house standards).

•Do not leave manifold pigtails disconnected; insects can clog them. Insects in oxygen pigtails can cause spontaneous ignition, creating enough heat and overpressure to burst the pigtail, valve, or manifold. Either replace empty cylinders immediately, or have the excess pigtails and valves removed or capped to keep them clean.

•In many facilities authorized personnel in maintenance, plant operations or Instrument/calibration shop may be able to provide a safety manifold system. (Refer to page D-7 for an example) This safety manifold system has been designed to reduce the pressure from a standard cylinder and provide relief protection for down stream systems (relief device). This manifold system can be used for low pressure (0-150 psig) applications not requiring formal documentation.

## Temperature Considerations

Pressure hardware is usually rated at ambient temperature of 70°F (21°C). Sometimes manufacturers will designate an MAWP based on lower or higher operating temperature. In general, the MAWP will decrease as operating temperature increases. When selecting components, always ensure the fitting material as well as any seals and packing can meet temperature requirements.

The temperature and working pressures for various sizes of copper solder fittings are shown below.

**Temperature vs. Working Pressure for Copper Solder Fittings**

| Solder | Size (in) | Temp. (°F) | Working pressure (psi) |
|---|---|---|---|
| 95/5 (Tin-Antimony) | 1/4 to 1 | 100 | 500 |
| | | 150 | 400 |
| | | 200 | 300 |
| | | 250 | 200 |

## Installing Pressure Systems

All work on pressure equipment that requires formal documentation must be done by or technically supervised by qualified personnel at your facility.

## Pressure Testing

Pressure test all systems in accordance with requirements in Appendix F, “Pressure Testing.”